

# Linear Motion

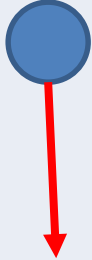
# Goals

- 1) Define speed, velocity, acceleration, and free fall
- 2) Apply mathematical relationships to predict what will happen in real-world situations

# Key Terms

Speed	How <u>fast</u> an object is moving	Equation: $s = d / t$
Instantaneous Speed	The speed at any <u>time</u>	<b>Example:</b> your car going 20 mph
Average Speed	The <u>total</u> distance covered in the <u>total</u> time	<b>Equation:</b> $s_{\text{avg}} = (\text{distance}_{\text{total}}) / (\text{time}_{\text{total}})$

# Key Terms

<b>Velocity</b>	Speed in any given <u>direction</u>	Example: 20 km/h NW
<b>Acceleration</b>	Rate at which <u>speed</u> changes	Equation: $a = \text{speed}/\text{time}$
<b>Free fall</b>	If ONLY <u>gravity</u> acts on the object	 A diagram showing a blue circle representing an object with a red arrow pointing straight down from its center, indicating the force of gravity.

Remember!

**Linear motion =**  
**objects move in a**  
***straight line!***

# Speed vs. Velocity

- Speed: how fast something is going
- Velocity: how fast and in what direction something is going (vector quantity!)

$$\vec{v} = \frac{d}{t}$$

# Velocity Examples

You want to drive 300 miles north in 5 hours. What will your average velocity have to be in order to make your goal?

# Velocity Examples

You are helping a pilot calculate her average velocity for a trip from Raleigh, NC to Denver, CO. The plane will travel 2800 km. If it takes 3.5 hours to make this trip, what will the average velocity be?



# Velocity Examples

Your average velocity in a plane is 900 km/h. If you travel 7000 km to go from Charlotte, NC to Paris, France. How long will it take you if you are going in a straight line?

# Velocity Examples

An aerospace engineer is choosing which type of engine to install in a commercial jet. This jet will need to safely transport civilians from San Francisco, CA to Sydney, Australia (a really long distance!). The engineer can choose between three different engines with 3 different safety ratings (out of a best possible 10). Which should she choose? WHY?

Plane with...

Engine A: can travel 1000 km in 1 hr, safety rating: 7

Engine B: can travel 2200 km in 2 hrs, safety rating: 6

Engine C: can travel 1200 km in 1.5 hrs, safety rating: 9

# Acceleration

Whenever we change our state of motion (speed or direction), we are **accelerating**

$$\vec{a} = \frac{\Delta \vec{v}}{t}$$

# Acceleration Examples

What is your acceleration if you go from 10 m/s to 30 m/s in 5 s?

# Acceleration Examples

What is your acceleration if you go from 0 mi/h to 120 mi/h in 0.05 s?

(THINK: unit conversions needed!)

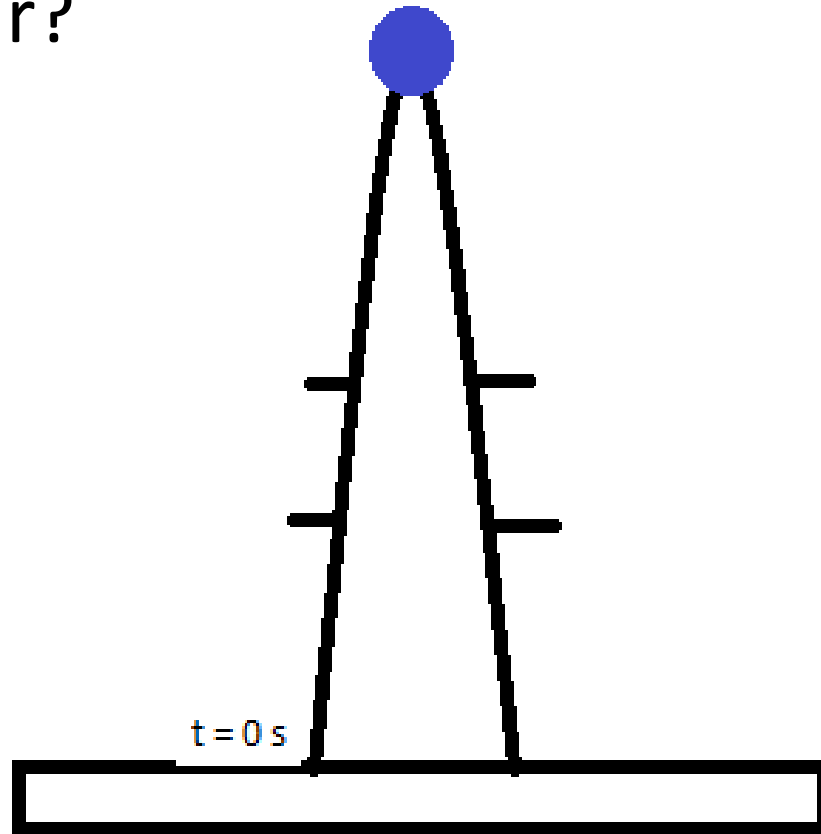
# Free Fall: How Fast

- Free Fall: ONLY GRAVITY acts on the object

Approximate Free Fall Speeds of Objects	
Elapsed Time (sec)	Instantaneous Speed (m/s)
0	0
1	10
2	20
3	30
4	40
t	$s = 10t$

# Free Fall: Rising Objects

So, is this the same for objects thrown straight up in the air?



# Free Fall: How Far

## Approximate Free Fall Distance of Objects

Elapsed Time (sec)	Distance Fallen (m)
0	0
1	5
2	20
3	45
4	80
t	$d = \frac{1}{2} g \times t^2$



# Free Fall Examples

You drop a ball from the Empire State Building. Assuming there is no air resistance:

- 1) What is the instantaneous speed of the ball after 8 seconds?
- 2) What is the distance traveled after 8 seconds?

# Review of Key Equations for Linear Motion

Use these when:

- Initial speed = 0
- Acceleration is constant (not “jerky”)

Key Equations:

$$\mathbf{a} = \frac{\Delta \mathbf{v}}{t}$$

$$\mathbf{d} = \frac{1}{2} \mathbf{g} \times \mathbf{t}^2$$